

Ground Water Flow Direction and Velocity Measurements Using the Variable-Focus Colloidal Borescope

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High installation costs limit the number of monitor wells at ER/EM sites. This limited coverage rarely provides sufficient resolution to determine local ground water flow patterns. To address this problem, a remotely controlled, variable-focus colloidal borescope was developed at Lawrence Livermore National Laboratory (LLNL) and recently employed at Sandia National Laboratories/New Mexico (SNL/NM). The borescope is capable of directly observing suspended colloids and determining local ground water flow direction and velocity in a monitor well in real time. The borescope consists of a waterproof video camera, flux gate compass, 36-136X lens, and illumination source. Video images of colloids are digitized, and flow direction and velocity (as low as 1 $\mu\text{m}/\text{sec}$ [0.09 m/d]) calculated.

Ground water flow directions and velocities were measured with the colloidal borescope at SNL/NM in November 1996 at Tech Area V, where site depth-to-water exceeds 500 ft, and complex hydrogeology result in anomalous water levels. The borescope measured a southerly ground water flow at velocities of 4-12 $\mu\text{m}/\text{s}$ (0.35-1.0 m/d), providing resolution of local flow patterns for future source area monitor well placement. Borescope measurements can also provide resolution for plume transport analysis, extraction system design, and engineered subsurface barrier monitoring.

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